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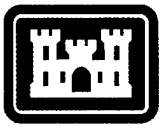

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Environmental Management Information System (EMIS) at Watervliet Arsenal, NY

by Jearldine I. Northrup, Joyce C. Baird, Phil Darcy,
and Donald J. Schiller

October 2000

Construction Engineering
Research Laboratory

Foreword

This study was conducted for Watervliet Arsenal (WVA), Watervliet, NY, under Work Unit VD8, "Environmental Management Information System." The technical monitor was Phil Darcy (WVA).

The Environmental Processes (CN-E) Branch, Construction Engineering Research Laboratory (CERL), within the U.S. Army Engineer Research and Development Center (ERDC), performed the work. Consultants MSE Technology Applications (MSE-TA), Butte, MT, provided engineering design services and construction and installation of equipment. Don Schiller was project manager for MSE services. The ERDC principal investigator was Jearldine I. Northrup, located at CERL, Champaign, IL. Jerry Benson is Branch Chief, CN-E, and Dr. John Bandy is Chief, Installations Division (CN), both located at CERL. The associated Technical Director was L. Michael Golish, CEERD-CVT. The ERDC technical editor was William J. Wolfe, Information Technology Laboratory.

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1 Introduction

Background

The Environmental Management Information System (EMIS) developed by Watervliet Arsenal and CERL was developed as an "evolutionary" rather than a "revolutionary" system. In that sense, EMIS was unlike the Facility Environmental Management and Monitoring System (FEMMS), which was deployed at Tobyhanna Army Depot and which was a revolutionary system. FEMMS was based on a similar design as the EMIS technology, but required major overhaul of the network and infrastructure. The evolutionary process at Watervliet Arsenal was due to the extent of the automation already in place at the start of the program. The concept was developed in 1991 in the then Advanced Technology Directorate at Watervliet Arsenal. This directorate was responsible for the fiber networks, the Distributed Network Control System and the Shop Floor Controls systems, which modernized data communications in the Arsenal. With these data systems in place for the manufacturing areas of the Arsenal, it was a logical next step to the facility infrastructure. With the introduction of Hazardous Materials Information Network (HAZMIN) in 1992 (also integrated by the Advanced Technology Directorate), the Environmental Network (ENVIRONET) and forerunner to EMIS was conceptualized. A major control upgrade was being developed for the Industrial Wastewater Treatment Plant and the Boiler Plant. A new Power Monitoring System (electrical monitoring and control system) was also underway. These standalone systems, although powerful, could not move critical infrastructure data to the end user.

In 1995 funds were programmed to supply the missing connections to the standalone systems already in place and in use. The consultant (MSE Technology Applications [MSE-TA]) was employed to enhance the measurement systems at the factory floor level, and to provide communications, server hardware, and software systems. This added missing data from several manufacturing systems. The integration with data warehousing technology was the last missing link to allow for web technologies to be added. Further enhancements included an upgrade to the HAZMIN system from the older Virtual Memory System (VMS) technology to Web based technology has also been included. Information is shared from a single web site. This allows the end user a "one-stop shop" for information generated by the system.

Additional enhancements to the manufacturing systems provide a conduit for manufacturing information to be sent to other data marts such as the Rotary Forge Data Collection System and the Statistical Data Collection System, which monitors critical processes in the manufacturing at America's Cannon Factory.

The software for EMIS was carefully selected, taking into consideration the wide variety of commercial-off-the-shelf-software (COTS) that is available. Using COTS enabled the EMIS developers to get the system up and running faster and more economically than by developing custom software, which would ultimately require support and upgrades. Developers wrote the bridging program for translating collection data bases to the data warehouse. The EMIS developers selected hardware capable of storing and handling a large and ever increasing amount of data to populate the data warehouse.

EMIS is designed to gather environmental information throughout WVA and to provide this information to compliance officers, to the plant floor, and to operations and alarm personnel when compliance is exceeded. The system can generate reports to meet some regulatory requirements and to assist in the centralized management of some environmental issues at WVA. EMIS consists of many modules and submodules and its development required the integration of a number of different COTS, one which acts as the system "backbone." The modules or cells that are included in EMIS at WVA are the Selas Furnace, Industrial Waste Treatment Plant (IWTP), Plating Facility, Fluid Storage Tanks, Electrical Energy and Power Monitoring System, Steam Production and Distribution, and the Weather Station.

EMIS is an automated tracking system designed to provide "cradle-to-grave" tracking of hazardous materials and their chemical constituents. The system was designed to provide a quick, accurate, and secure way to receive, distribute and track hazardous materials and to track the accumulation and disposition of hazardous waste at WVA. EMIS is a cost-effective method of monitoring, controlling, and reporting all waste streams and potential environmental impact. In some cases, control is an added feature, but this was not the primary intent of EMIS. The system provides Federal environmental reports and maintains the required information for State and local environmental security management reports using COTS. Logical Technology, Inc. and Pacific Environmental Services, Inc. (PES) have entered into Cooperative Research and Development Agreement (CRADA) with CERL to provide software for this project. One of the selected COTS for the project, HAZMIN, is an automated tracking system designed to provide "cradle-to-grave" tracking of hazardous materials and the chemical constituents of these materials. By using these COTS, EMIS will maintain material chemical constituent information, chemical hazard information,

store chemical release information for processes, and will track hazardous materials used and spilled, and hazardous waste disposed. The main impact of the system is the timely transmission of information to all site personnel responsible for the effective safety of the arsenal and its environment. EMIS will provide information to personnel so that problems may be avoided by the active minimization of waste streams, the correct management and handling of hazardous materials, and the proper management and disposal of hazardous materials and emissions. EMIS will also have the capability to interface with other automated information systems (AIS) and standard supply systems.

One of the main issues addressed in designing and developing WVA's EMIS was to use standardized data elements so that data exchange between systems could be accomplished in the future. The EMIS developers selected to use the standardized Department of Defense Data System (DDDS). From DDDS data dictionary and the DOD Data Model (DDM), data entities and data elements were chosen to match the data needs of EMIS. A data warehouse is the compliant area and the COTS are left in their original form. Management information is transferred by machine and stored in the data warehouse for long-term usage.

Objective

The objective of the project at Watervliet Arsenal (WVA) was to develop an automated system to network process areas and allow the collection of information. This will lead to the reduction of energy, water, and waste costs, adherence to compliance laws and regulations, and improvement in manufacturing processes and the resulting products. However, the overriding objective of the project is to protect the environment and the local population both inside and outside of WVA by preventing pollution. (Under Executive Order 12856, pollution prevention means the source reduction and other practices that reduce or eliminate the creation of pollutants through increased efficiency in the allocation of raw materials, energy, water, and other resources.)

Approach

Advanced sensor and computer technologies and techniques were selected and installed. Among these were tools to collect and record information from industrial equipment and systems, including the Selas furnace, the industrial waste treatment plant, plating operations, fluid storage tanks, the electrical energy and power monitoring system, steam production and distribution, and the weather station and its associated equipment. Commercial-off-the-shelf software

packages were selected according to specific needs and an Oracle data warehouse was installed to store data elements needed for reports. The Department of Defense Data System (DDDS) was used to select relevant data elements and the data tables were taken from selected ERwin/Platinum Data Models.

Mode of Technology Transfer

It is anticipated that the Environmental Information Management System (EMIS) and accompanying documentation will be available on the CERL and WVA web pages:

http://www.cecer.army.mil/
http://www.wva.army.mil/

2 Environmental Management Information System (EMIS)

Watervliet Arsenal has initiated the implementation of EMIS. This system will collect data at the sensor level critical to meeting strategic business objectives and to ensuring environmental compliance, thus avoiding long-term liability. The system will be used to capture, transmit, and store environmental information provided by existing and planned systems. The information in this chapter was obtained from current and planned projects. Figure 1 shows the general layout of EMIS.

EMIS Computer Upgrade

A new Microsoft NT server for data warehousing and Oracle programming has been procured. The Department of Defense Data Dictionary System (DDDS) data mapping was used to produce the Oracle Data Mart on this platform.

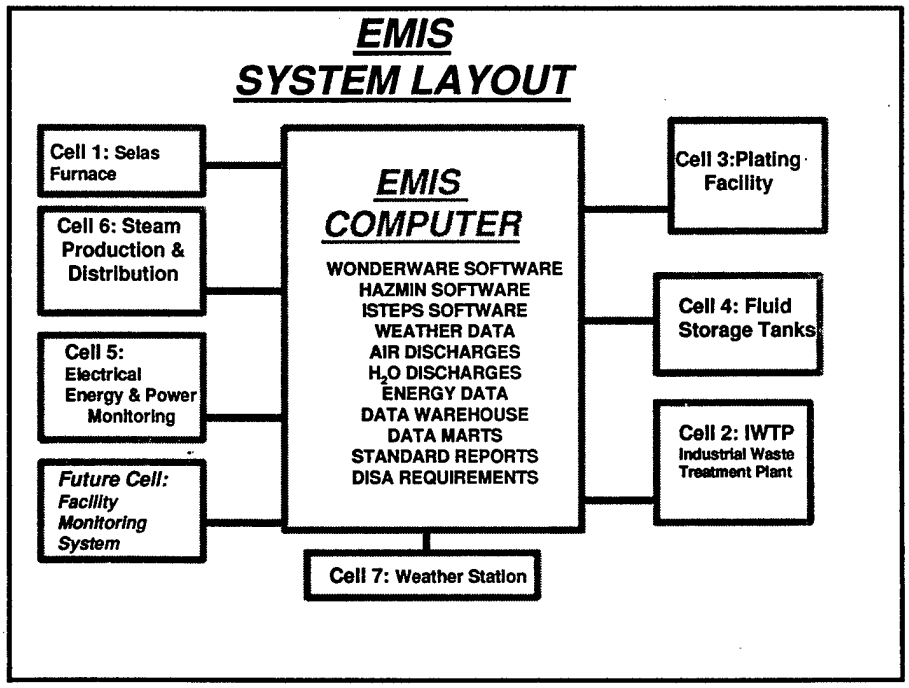

Figure 1. Environmental Management Information System (EMIS) layout.

Hazardous Material Information Network

Logical software (HAZMIN) was upgraded to an Oracle platform and web browser technology was employed for user interface of the Material Safety Data Sheet (MSDS) information. Other user interfaces are being upgraded to web-based platform under a Cooperative Research and Development Agreement (CRADA) with the vendor. Shop floor personnel will use Personal Computers (PCs) and the web browsers to interface with the WVA Intranet.

Industrial Waste Treatment Plant (IWTP)

Installation of this system is complete. Data communications to the Intranet network were developed to address a number of the 1700 points of data generated in the plant. The Wonderware software system is used to control the IWTP. To avoid inappropriate access to the IWTP process, another information system was placed side by side. Information is collected from the control system and passed one way to the data warehouse system.

Boiler Plant Controls

At this writing, new boilers had been installed, but the programmable logic controller (PLC) that was purchased as part of another project was not currently functioning. Upgrading the existing controls will allow the data generated from boiler operations to be transferred to the central data warehouse. Additional connections will be made to the fuel cell and the new Donlee Boiler when the work is finished on the boiler. At that time, one PLC will be used to control all information from boilers needed for EMIS.

Power Monitoring System

Upgrade to this system provided access to electrical consumption to be transferred under a web browser technology.

Plating Operations Information System

This project collects data from the Automated Chrome Management System (ACMS) and transfers the information to the central data warehouse. This will

be shared with manufacturing systems to provide statistical process control (SPC) for the process.

Air Emissions Monitoring System

This system is monitoring operational parameters on the Chrome Scrubbers in Majors and Minors. This provides (real-time) feed back as a compliance monitor to Operations and to the Safety, Health, and Environmental Division.

Storage Tank Monitoring System

This provides real-time monitoring of level and leak detection of 26 above- and underground storage tanks. This is centralized at the Fire Department and is transmitted to the Safety, Health, and Environmental Division.

Weather Station

The weather station provides real-time information on current local weather conditions. This allows for tracking and monitoring of conditions at the Arsenal.

Army Command Reporting Systems

Interfaces into standardized DOD software systems are being developed to provide input to these reports in automated format. The central data base is compliant with Defense Information System Agency (DISA) data dictionary standards, which allows for formatted data to be transferred to these systems.

Personnel Environmental Training Records

Training records are being maintained on a centralized system. This allows for the installation to keep good training records on persons whose responsibilities require them to respond to hazardous materials related events, to work under hazardous conditions, or on individuals who may otherwise be exposed to hazardous conditions.

Environmental Regulations

Current regulations are being added to the HAZMIN system to query the data base for chemicals newly listed in recent regulations.

The availability of these automated data collection systems and this online data query capability will allow WVA to satisfy environmental reporting requirements. This information will also act as a vehicle to maintain compliance and to identify and quantify the success of pollution prevention efforts currently being undertaken at Watervliet Arsenal.

3 Technical Implementation

Project Technical Goals

The main goal for the EMIS project at WVA is to minimize risk and cost in environmental compliance. After the data are accumulated, the process of retrieving, manipulating, and displaying the data provides:

- automated compliance management and reporting
- alarming and alerting when a system is in violation or is operating out of specification
- trending to determine if a process is heading for a possible violation where planned maintenance can prevent costly problems such as a spill
- hazardous material reporting to assist in management in storage and disposal
- Material Safety Data Sheet (MSDS) display
- records management and archiving.

The secondary goal for EMIS is to provide systems and process enhancements that will help reduce energy use and provide quality assurance feedback to prevent re-work, all of which provide efficiencies that yield a general environmental benefit.

EMIS Project Phases

The EMIS project was structured into separate work groupings or tasks, called "cells," each of which relates to a major plant process or function data feed. The work in each process cell falls into two phases.

Phase One

Instrumentation and control systems (if required) were upgraded on the factory floor to provide operational reliability and data access. Node computers were installed to provide a single-point access to the data.

Phase Two

This phase provided data and network connections, and developed software applications at the network node computer. The computer was connected directly to the measurement instrumentation or through the PLCs allowing local operator access to the raw data. Depending on the cell, operator displays and/or control outputs may have been developed on the node computer to enhance the operation and bring the system under better control. A plant network termination connected the field data node computer to the facility Intranet. Software applications on this computer node moved the data to the central EMIS data base server.

Two unique cells were the Server Interface Cell, and the Web Page Development Cell. The work in these cells progressed in parallel with all other tasks to build the data base and data retrieval/reporting systems that were fed by the factory-floor data node computers.

Data Locations

One function of EMIS is to obtain data from many sources. Figure 2 shows data locations. Data sources can be:

- available from instruments placed in various locations, which could be in tight groups or widely dispersed
- stored within existing PLCs
- stored within existing computer data bases or within software applications that may or may not provide easy access (for example, some older "legacy" proprietary systems using UNIX operating systems with sketchy documentation)
- data from manually input tables.

This made the data gathering task challenging. To pull the data into a common data base location, various types of network pathways and connections were used "as is," or were added as required as described in the next section.

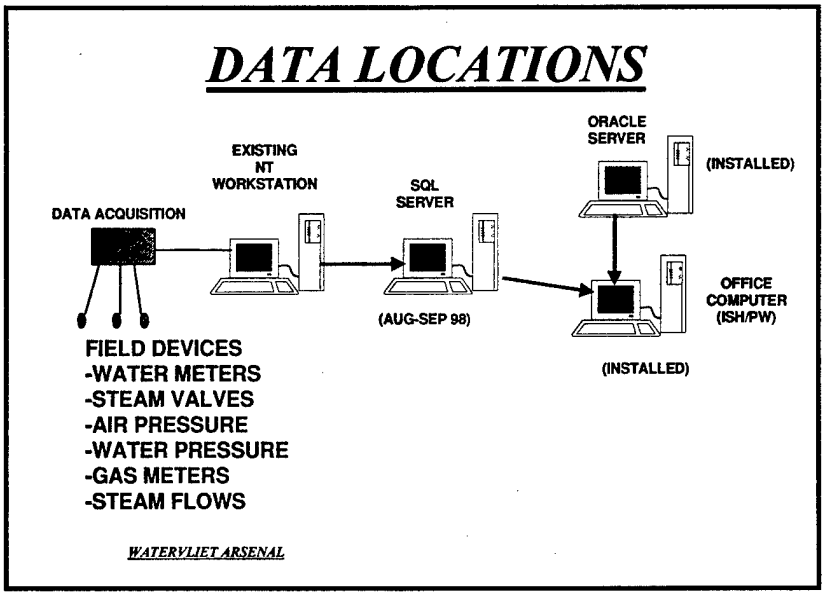

Figure 2. Data locations.

Data Pathways

Various pathways and networks move the EMIS data. Note: there are several network types:

Physical Pathways

- **Direct wiring** is used to connect the measurement instrument or control device to the PLC.
- **Telephone line data access** is a very cost-effective means of obtaining data from widely dispersed and remote data sources. The data travel through phone lines using the RS-485 communications standard. The method uses simple and reliable communications devices and protocol.
- **Spread-spectrum radio modems** are an alternative means of achieving radio access to remote data where telephone lines are unavailable and it is not practical to run wiring conduits. The remote radio modem locations were polled from a master. When the correct address was received from the master, the remote radio answered with the current data.
- **PLC network** is an industrial network that uses a proprietary wiring and communication method. This network was designed for control systems used on the factory floor or other industrial processes. At WVA, the Allen-Bradley Data Highway Plus network is used to connect PLCs in the Building 35 chrome-plating processes to allow a single access point for EMIS.
- **An Ethernet TCP/IP (Intranet) network** consists of the wiring, fiber-optic cabling, routers, server computers, and software systems that are used for

the WVA Intranet. This network is used to move data from the factory-floor network node computer to the central data base computers. It is also used for access to the data for use in reporting or alerting.

Software Pathways or Connections

- **Connections to environmental software packages** are provided in most of the newer commercial packages by using open data base connectivity (ODBC) standard method, which was employed for EMIS. (This is currently a widely used, nonproprietary industry standard.) The advantage of the ODBC standard is that it removes the need for developers and maintainers to learn several ways for data bases to talk to each other. Older software packages, however, may require creative methods to move data into and out of a proprietary data base format.
- **Data entry from a terminal.** Parameters such as material code name or results from chemical analysis may require manual data entry from a terminal. This is provided to the data entry operator on Intranet computers using either a web browser form, or a Wonderware COTS terminal.

Data Classes

EMIS was built on the concept of two major classes of data depending on intended end use, "factory floor" and "data warehouse."

Factory Floor

The "factory floor" raw data arrive direct from the measuring device, usually at a faster sample rate than warehouse class data. Each data sample is stored in a data base record and is time-stamped. These data records are not described in standard DOD format. They are usually stored for shorter periods and are displayed on the PLC operating stations or the factory-floor data node computer human-machine interface (HMI) display for use by the operator in process monitoring and diagnostics.

Data Warehouse

These "data warehouse" aggregated data are intended for long-term storage and are sent through the Intranet to the warehouse data base central computers. The data conform to the DOD data dictionary standard format, and are usually averaged hourly, daily, or yearly as opposed to the more rapidly sampled factory floor data stream. The data dictionary standard format benefits the military by

allowing global data access using a standardized format. In EMIS, factory floor data are passed to the warehouse data base using bridging software.

Security

Security is required in WVA EMIS to:

1. *Prevent Unauthorized Access to WVA Intranet through EMIS.* Unauthorized users must be prevented from gaining access to the WVA Intranet through EMIS. This is accomplished using careful attention to details and policies such as not installing "back door" access, and following WVA security rules.

2. *Prevent Malicious Activity by Unauthorized Users.* Malicious activity could compromise a process system and potentially cause physical damage. At the Industrial Waste Treatment Plant (IWTP), a simple "bastion host" computer was inserted into the network connection to prevent unauthorized network access to this critical process.

Field Data Nodes

The following chapters describe field data nodes, or cells.

4 EMIS Cell One: Selas Furnace

Background

Selas furnace is a critical part of the gun tube production process, which provides metal hardening using electrical or gas-fired heating and water quenching cycles. EMIS provides strategic and environmental data access to the process. Figure 3 shows a schematic diagram of Cell 1 – Selas furnace.

Phase one of the WVA Selas EMIS project was completed in 1998. This phase provided control system enhancements that improve the reliability, operability, and safety of the plant. After the completion of the phase one enhancements, the Selas furnace operator can now select a "recipe," or heat treatment profile, from a selection list. When selected, all parameters for the recipe are automatically set up in the controller to optimize the gun tube heat treatment process. The operator also has available manual selections and adjustments to allow optimizing or fine-tuning the temperature of each zone in the process.

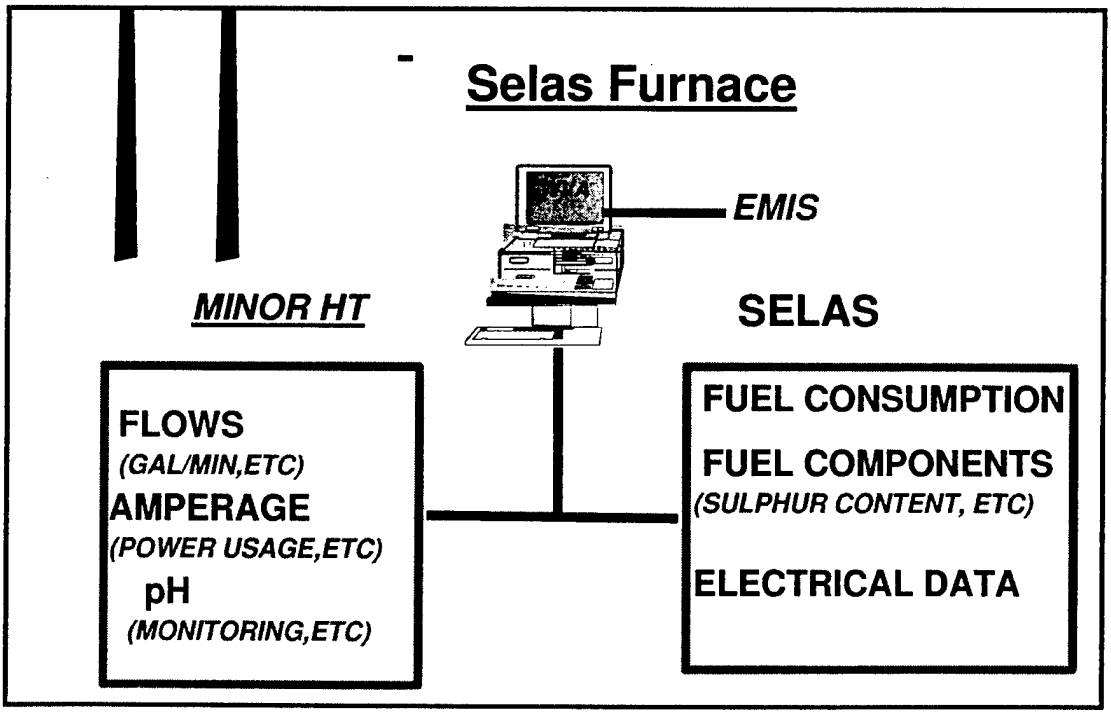

Figure 3. Cell 1 - Selas furnace.

During periods of demand for high production rates for finished gun tubes, the operator can now change multiple temperatures to the treatment profile within minutes. Temperature profiles stored in the computer data base can now be compared with hardness of the finished product and used in the quality control. Monitoring and optimizing tools provided to this process by EMIS can be used to save gas, water, and electric power. The EMIS data base records total Selas furnace natural gas usage, a major environmental impact at the Arsenal.

Provided in Phase One

Programmable Logic Controller (PLC)

This allows automatic sequence control.

Process Monitoring Computer

This allows human-machine interface (HMI) to the Selas heat treatment process.

Wonderware COTS HMI Software

This software was selected to display the process in graphic format and allow operator control interface to the process. This software also provides data acquisition and temporary storage. The software running on the Selas process node also provides the EMIS data base with data from the process. Enhancements were also provided in the HMI software for the recording and archiving of quality assurance (QA) data. These data are made available as a tool for process analysis and possible improvements.

Provided in Phase Two

Network Connection

The network connection between the process monitoring computer and the EMIS data base through the WVA Intranet allows it to function as an EMIS factory-floor network node computer. Software connections provide access to all Selas furnace data from the EMIS data base computers.

Web Browser Data Monitoring Screen

This screen allows the process to be monitored from any computer connected to the WVA Intranet. A Netscape Navigator or Microsoft Internet Explorer browser will display the Selas furnace process data and historical trend from a page selected from the Watervliet Intranet System (WINX) home page.

5 EMIS Cell Two: Industrial Wastewater Treatment Plant (IWTP)

Background

The industrial wastewater treatment plant (IWTP) treats wastewater from the factory production activities and discharges treated water. If the IWTP fails, hazardous material may spill or be discharged into the Hudson River. EMIS phase one was implemented to bring the IWTP under reliable control. Phase two provided environmental management tools such as trending and reporting. Figure 4 shows a schematic diagram of Cell 2 – Industrial wastewater treatment plant (IWTP).

Completed in 1997, phase one of the IWTP EMIS project was a major reliability, operability, and safety upgrade to the plant. Many outdated measurement and control instruments were replaced. Central control capability provided critical information, start/stop and adjustments capability to the operator at the local control panel. A clean control room with a HMI display was installed to allow overview of the system operation.

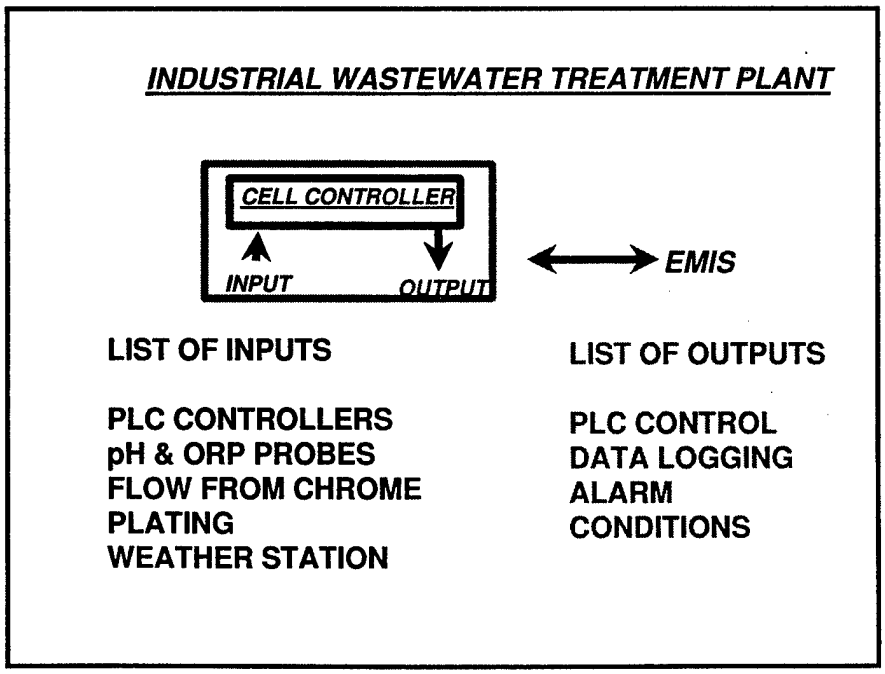

Figure 4. Cell 2 - Industrial waste treatment plant (IWTP).

Provided in Phase One

Improved Instrumentation

This was to replace many aging and unreliable measurement instruments, such as flow, level, and pH and ORP probes. Some new instruments were added.

Improved Electrical System

This replaced the electrical conduit, wiring, grounding, and motor starters on many subsystems per National Electrical Code (NEC) requirements.

New Central Control Panel

This panel was installed near the treatment process, and includes all displays, controls, and alarms required for efficient and safe operation. A satellite panel was installed in the lower level of the building to function as a gathering point for more remote signals on the northeast corner of the building. All field instruments and controls are wired directly to the two panels using sturdy rigid conduit. The master control panel is a free-standing double-door unit including an Allen-Bradley PLC-5/40E PLC, pushbuttons, indicator lights, gauges, Moore PID controllers, and an Allen-Bradley color Panelview™ alarm display. The satellite panel includes an Allen-Bradley remote input/output (I/O) rack to collect signals and bring them back to the master PLC using remote I/O wiring.

Human-Machine Interface (HMI) Computer

The HMI computer is located in a clean control room. It was installed in a windowed control room sitting above the process and linked to the PLC using an Allen-Bradley KTX plug-in card wired with a proprietary Data Highway Plus (DH+) network. Wonderware InTouch™ HMI software was installed on a computer running Microsoft Windows NT version 4.0 (Workstation operating system). The operator can operate and monitor the treatment plant using either the keyboard or the mouse. Alarms and process measurements are displayed in graphical format that approximates how the process actually looks.

Provided in Phase Two

Network Interface Computer

A network interface computer running Microsoft Windows NT version 4.0 (Workstation operating system) was installed to connect the IWTP control and measurement system to the EMIS network. This computer functions as a "bastion host" to allow authorized access to the IWTP data, while preventing unauthorized access to the process control functions through the EMIS network. This computer also functions as the factory-floor network node computer connected to the WVA Intranet.

Separate Sub-Network

A separate sub-network was installed from the bastion host to the IWTP. This completely isolates the IWTP process from the Intranet. Data are passed from the IWTP to the bastion host using a program that provides one-way flow only. With this system, an unauthorized user cannot change operating parameters on the IWTP process computer.

Web Browser Data Monitoring Screen

This web browser data monitoring screen allows the process to be monitored from any computer connected to the WVA Intranet. A Netscape Navigator or Microsoft Internet Explorer browser will display the IWTP process data and historical trend from a page selected from the WINX home page.

6 EMIS Cell Three: Plating Facility

Background

WVA EMIS has the following three chrome-plating subsystems:

- 120mm gun tubes
- new medium tube (NMT)
- minor plating (miscellaneous parts).

Figure 5 shows a schematic diagram of Cell 3 – Plating facility. It is anticipated that the WVA air permit affecting the chrome process may change in the near future. To meet current and anticipated future permit requirements, EMIS provides data for the following two reporting methods for emissions compliance at each subsystem:

1. Scrubber performance data (flow rate and filter differential pressure), which support the current reporting method
2. Rectifier current data for each plating cell (with a known tank surface area), which should fully support future requirements.

Phase one of the chrome-plating facility upgrades provided factory floor compliance reporting data.

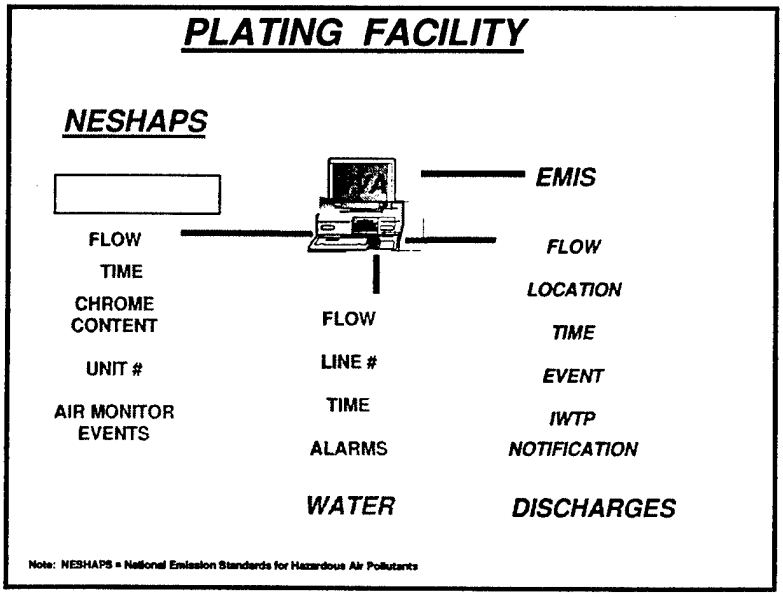

Figure 5. Cell 3 – Plating facility.

Provided in Phase One

Improved Instrumentation

Improved instrumentation replaced many aging and unreliable measurement instruments, such as pressure, flow, and electrical current.

PLC

Upgrades to PLCs enhanced the data acquisition and improved alarming and control. An Allen-Bradley PLC was installed in each of the new medium tube (NMT) and 120mm plating lines. They were interconnected with existing PLCs in the process using Allen Bradley Data Highway Plus industrial network.

Process Monitoring and Control Computers

Process monitoring and control computers allow HMI at the chrome-plating processes. One computer was installed in each of the 120mm and the NMT processes.

Wonderware COTS HMI software

Wonderware software is used to display the process in graphic format. This software also provides data acquisition and temporary storage. New process displays developed for Phase one enhance the operation by providing an overview of the entire process. The operator can view trends in tank currents and temperatures from the process monitoring computer. Enhancements were also provided in the HMI software to record and archive quality assurance (QA) data. These data are made available as a tool for process analysis and possible improvements.

Provided in Phase Two

Network Connection

The network connection between the process monitoring computer to the EMIS data base through the WVA Intranet allows it to function as an EMIS factory-floor network node computer. Software connections provide access to all plating facility data from the EMIS data base computers.

Web Browser Data Monitoring Screen

This screen allows the process to be monitored from any computer connected to the WVA Intranet. A Netscape Navigator or Microsoft Internet Explorer browser will display the plating systems process data and historical trends from a page selected from the WINX home page.

7 EMIS Cell Four: Fluid Storage Tanks

Background

Fluid storage tanks at WVA store fuel oil and process waste fluids. EMIS monitors 26 critical tanks, located both above ground and underground, for fluid level.

Level and leak/overfill monitors were pre-existing at WVA for all tanks except the heating plant fuel oil tanks, where new Consilium Metritape™ level gauges were installed. Pre-existing instrumentation includes underground waste tanks with level sensing and leak detection and alarming, and underground fuel oil tanks with level sensing and overfill detection and alarming. Figure 6 shows a schematic diagram of Cell 4 – Fluid storage tanks.

Phase one of the fluid storage tank monitors was completed in 1998, including the final report, *Remote Monitoring of Fluid Storage Tanks at Watervliet Arsenal, New York* (August 1998). This report can be accessed from the CERL web site at: http://cecer.army.mil/

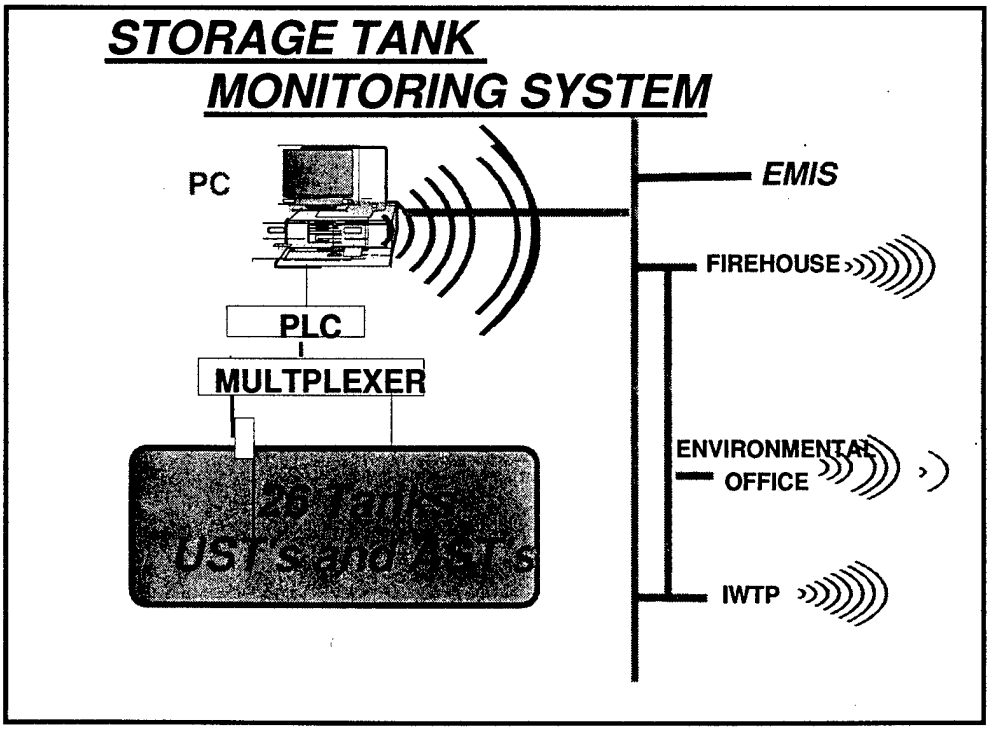

Figure 6. Cell 4 - Fluid storage tanks.

Mouse click to open the site and then select **Publications and News** from the Menu at the left side of the screen. Then select **Technical Reports**. Scroll down to **98/108** and click on this to open the report. The reports are currently available in Adobe Acrobat® PDF format and/or HTML.

This phase provided interface connections and field wiring to leak/overfill alarms and level gauges on 26 remote storage tanks, most of them located underground and used for storage of process waste fluids and fuel oil.

Existing telephone lines were used to connect the tanks to a communications center, saving the considerable cost of field conduit and wiring.

Provided in Phase One

Network Interface Boxes

Network interface boxes were installed at each of the tanks to convert the tank level signal (standard 4-20 mAmp) and the leak/overfill alarm (on-off) into data that can be streamed on two wires (standard RS-485 serial communications).

Telephone Wire Connections to the Communications Center

Telephone wire connections to the communications center were installed to connect all the tank signals back to a single-point "hub."

Broadcast Hub

The broadcast hub was installed on a communications rack in Building 110 communications center to consolidate the signals from all tanks to a single pair of wires connected to the remote firehouse computer.

Alarm Computer

An alarm computer was installed in the firehouse where 24 hour, 7 days a week monitoring and response is available.

Polling Software

Polling software was installed on the alarm computer to send an address signal sequentially to each of the tanks. When a tank network interface box receives the correct address code, it transmits the tank level and leak alarm status back

to the hub, and on to the firehouse computer as a response signal. Any detected communications problems will trigger a trouble alarm at the firehouse. This software was developed using Microsoft Visual Basic.™ Links from the tank data to the Wonderware software are made available for display and storage.

Wonderware COTS HMI Software

This was installed in the alarm computer to display the fluid tank system in graphic format, and to handle the alarming, trending, and storage functions. The computer HMI displays a graphical top view of WVA buildings with the tanks shown in their actual location. The tank graphic displays the tank level and any alarms, with critical situations showing up in yellow or flashing red with audible alarm. By clicking on the tank graphic with the mouse, a window pops up displaying a large tank graphic with animated fill level, and miscellaneous tank details. A historical trending chart for the tank is also displayed. A click of the mouse also brings up a telephone call list for operator notification of tank alarms.

Provided in Phase Two

Additional tanks were connected to bring the total to 26 tanks. New Consilium Metritape™ level gauges were installed on the two boiler plant fuel oil tanks. It was not practical to connect using telephone lines or buried conduit to these two tanks, or to two other remote underground waste tanks. To provide communications, a relatively new communications method using "spread-spectrum radio modems" transmitters was installed. The radios functioned as a simple wire replacement and allowed the bi-directional transmission of data to and from these tanks to the nearest telephone line, and the broadcast hub in the communications center. These special modems were fairly simple to apply. These modems are connected by attaching the single pair of wires at each end to a small box, which includes an antenna and a power supply.

Network Connection

A network connection between the process monitoring computer located in the firehouse to the EMIS data base computers through the WVA Intranet allows it to function as an EMIS factory-floor network node computer. Software connections provided access to all fluid storage tank data from the EMIS data base computers.

Web Browser Data Monitoring Screen

The web browser data monitoring screen allows the process to be monitored from any computer connected to the WVA Intranet. A Netscape Navigator or Microsoft Internet Explorer browser will display the tank levels and historical trend from a page selected from the WINX home page.

8 EMIS Cell Five: Electrical Energy and Power Monitoring System

WVA uses considerable amounts of electrical energy for several processes including heat treatment and electroplating. Reductions in energy use can result in cost savings and reduced impact on the environment.

WVA has taken a significant first step by installing a Square D™ SyMax power monitoring system that allows the public works department to monitor electrical energy usage, demand factors, and diagnostics information throughout the facility. Remote power monitor units were installed at most of the power usage substations. These remote units were connected by dedicated telephone wires to SyNet network cards located in Square D racks in Building 110 communications room. The network cards were in turn connected to a power monitoring computer located in Building 120 using a telephone line pair. Proprietary Square D software polls all power monitors periodically, updates the records on power usage, and makes available all power data for tabular or graphical display.

The EMIS project provided a separate polling connection between the SyNet network cards in Building 110, and a new network node computer located in the same room. This made the data available to the EMIS data base computers on a separate but parallel path while not disturbing the primary data path and usage for public works.

EMIS provided all of WVA with access to all power monitor data on any computer on the WVA network. The payoff for this system is that it provides the ability to monitor and analyze the power usage profiles at a local level so energy reduction programs can be implemented on the factory floor. Of particular interest is the potential for cost savings by reducing monthly demand factor (15 minute) at each metered point. This could be attained by demand meter monitoring (right from the factory floor) to schedule production to avoid very high demand charges. Figure 7 shows a schematic diagram of Cell 5 – Electrical Energy and Power Monitoring System.

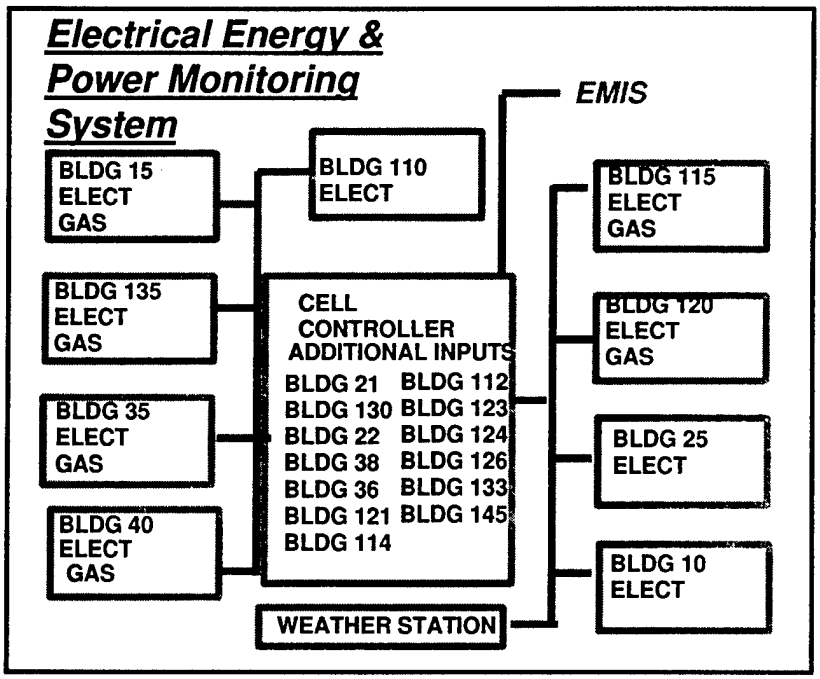

Figure 7. Cell 5 - Electrical energy & power monitoring.

Provided in Phase One

Network Node Computer

A network node computer was installed in Building 110 communications room. The SyMax /SyNet PC option board was installed in the computer.

Field Network Connection

Field network connection from the Square D SyNet network to the SyMax PC option board was made. This tapped into the existing proprietary network allowing access to all data points on the power monitors.

Data Access Software

Data access software was installed on the network node computer. Access to each power monitor data point was provided by configuring the SyNet input/output drivers included with Wonderware Intouch.™

Provided in Phase Two

Network Connection

A network connection between the network node computer and the EMIS data base through the WVA Intranet was provided. The EMIS data base server computers provided software connections allowing access to all power monitoring data.

Web Browser Data Monitoring Screen

The web browser data monitoring screen allows the process to be monitored from any computer connected to the WVA Intranet. A Netscape Navigator or Microsoft Internet Explorer browser will display the plating systems process data and historical trend from a page selected from the WINX home page.

9 EMIS Cell Six: Steam Production and Distribution

Steam Production and Distribution Processes

Steam production and distribution includes two processes. The first process is steam production, consisting of the boiler plant and steam production facilities. The second process, steam distribution, consists of the heating, ventilating, and air conditioning (HVAC) systems located in the various buildings that currently have pneumatic or non-digital control.

Steam Production

The steam plant consists of two existing boilers and one in the process of installation. These boilers produce steam for building heating and hot water for domestic use. Figure 8 shows a schematic diagram of Cell 6 – Steam Production.

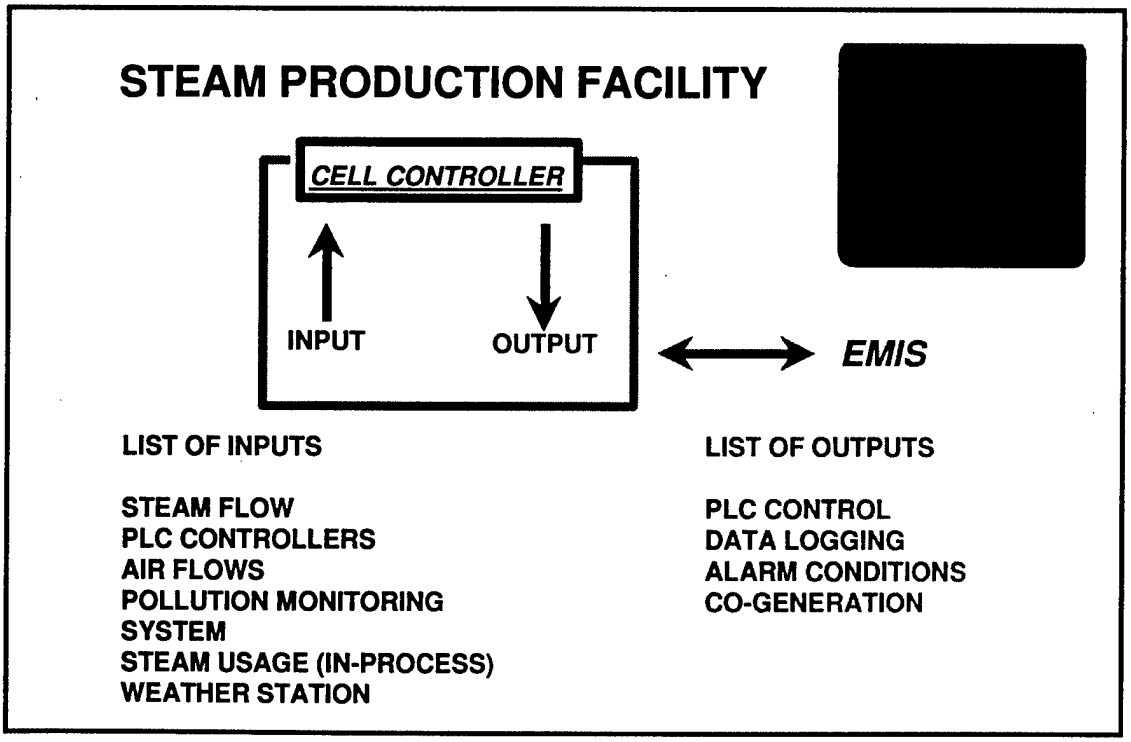

Figure 8. Cell 6 - Steam production facility.

Provided in Phase One

Field Instrumentation and Data Are Not Yet Available

This separately funded project is scheduled to begin in the near future. The current plans under discussion are to replace the existing PLC in the central control room to provide enhanced control and data acquisition capabilities. The primary data of interest is the energy usage, and perhaps some form of stoichiometry monitoring to improve efficiency, reduce energy use, and control pollutants. Also under discussion is purchasing and installing a point-source continuous emissions monitor system (CEMS) to provide air emissions tracking.

Process Monitoring and Control Computer

The process monitoring and control computer allows HMI to all processes at the boiler plant. A PC was upgraded to Windows NT 4.0™ and the software was upgraded to Wonderware Factory Suite 2000™. This is connected to the existing Toshiba™ PLC and displays boiler process parameters in graphics display. This computer functions as the Network Node Computer.

Provided in Phase Two

Phase Two will provide a network connection between the network node computer and the EMIS data base through the WVA Intranet. The EMIS data base server computers provided software connections allowing access to all boiler plant data.

Steam Distribution

Provided in Phase One

Steam Monitoring and Control Subsystems

These were installed in many of the buildings throughout WVA. Johnson Controls was the subcontractor for this phase.

Field Mounted Gauges and Controls

These were installed for a comprehensive steam distribution control and monitoring system.

A Central Energy Management Computer System

Metasys™ Software was installed in Building 120. This provided automated data collection, data entry, data manipulation, trend analysis, and report generation for five buildings. The Metasys™ can be used for real benefit to reduce energy costs.

Provided in Phase Two

Network Connection

This network connection joins the polling computer to the EMIS data base through the WVA Intranet to allow it to function as an EMIS factory-floor network node computer.

Web Browser Data Monitoring Screen

This is for monitoring the process from any computer connected to the WVA Intranet. A Netscape Navigator or Microsoft Internet Explorer browser will display the Metasys data and historical trend from a page selected from the WINX home page.

Provided in the Next Phase (Currently in Funding Distribution)

Steam Mass Flow Meter Connections

These connections would be installed at the remote building locations. This would bypass the Johnson Controls Metasys™ system and use a direct polling method similar to that used for underground storage tanks discussed above. Figure 9 shows the proposed steam distribution system components.

Figure 9. Cell 6 – Proposed steam distribution components.

10 EMIS Cell Seven: Weather Station

The EMIS weather station was installed to provide black body temperature enabling air emissions modeling. This supports evacuation planning for any gaseous hazardous materials container rupture. Figure 10 shows a schematic diagram of Cell 7 – Weather Station.

Provided in Phase One

Weather Tower

The weather tower is located on top of the elevator penthouse of Building 120, which is one of the tallest buildings in the arsenal. The tower is a 40-foot retractable aluminum mast.

Instrumentation

The instrumentation included is for recording wind speed/direction, temperature, relative humidity, solar radiation, and accumulated radiation. The weather instruments were connected to the weather monitor system located in an environmentally controlled housing in the penthouse.

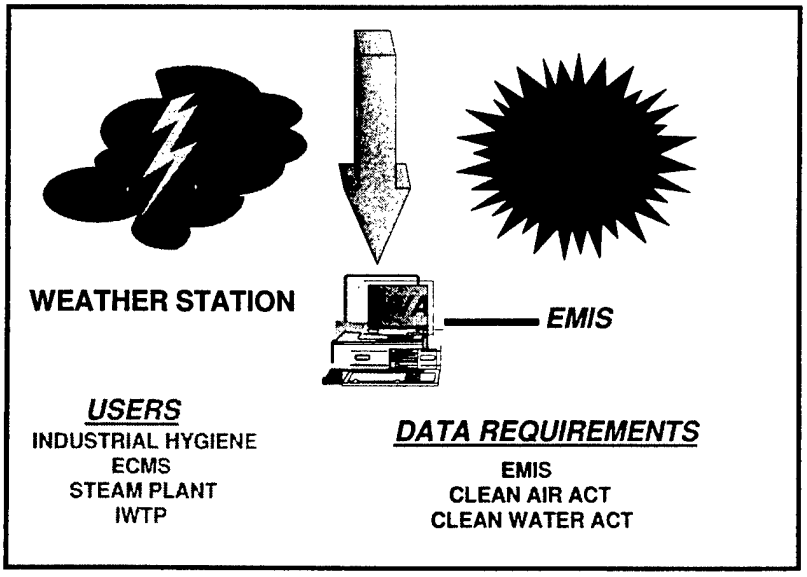

Figure 10. Cell 7 - Weather Station.

Network Node Computer

A network node computer was also installed in an environmentally controlled housing in the penthouse. A Microsoft Visual Basic™ program was developed, compiled, and installed on this computer to access the data on the weather monitor and make it available to the EMIS data base computers.

Provided in Phase Two

Network Connection

A network connection was provided between the network node computer and the EMIS data base through the WVA Intranet.

Web Browser Data Monitoring Screen

The web browser data monitoring screen allows the process to be monitored from any computer connected to the WVA Intranet. A Netscape Navigator or Microsoft Internet Explorer browser will display weather data and historical trend from a page selected from the WINX home page.

11 EMIS Web Page Development

Background

The major user interface selected for the EMIS project was standard PC hardware running the Microsoft Windows™ operating system, and either Microsoft Internet Explorer™ or Netscape Navigator™ Intranet/Internet browser. The browser displays the data and other information on the process in tabular or graphical format. Using a browser to access data simplifies and streamlines the entire process of interfacing the EMIS to any user. All that is required of the user is that he or she has a computer, a browser, a password, and a network connection in the arsenal. The browser interface technology for displaying data in this manner was not available until recently, and can now be used to save considerable cost in hardware and software user interfaces.

The EMIS network is accessible on the WVA Intranet System (WINX) by simply typing the words WINX on the browser location address line. The browser sends requests for data pages to the Microsoft Internet Information Server (IIS) located in the Information Management server cluster room located in Building 20. The IIS uses Microsoft Active Server Pages (ASP) technology to deliver enhancements to the browser interface on the user's computer.

The EMIS project has developed fairly simple software modules for data display called "Web Pages" and installed them on the IIS. Each web page performs a user interface function such as displaying continuous data updates, or a trend chart. A master web page called the "WINX home page" contains links to other pages (which may, in turn, link to other pages) in a hierarchical fashion. Most web pages in EMIS display information from a data base, or factory floor production system, but they can be used to navigate around EMIS, provide data input, plot data graphs, or manage the data.

One advantage of this technology is that it is easy to create new or modify existing pages. Even current word processors, such as Microsoft Word, provide a means of modifying or creating web pages directly.

Characteristics of the Web Pages

Selas Furnace

This web page primarily displays natural gas usage, and can be easily modified to display any production data that are on the factory floor network node computer, such as zone temperatures, gas flows, set points, treatment profile in use, quality control data, quench water flow, etc.

Industrial Waste Treatment Plant (IWTP)

In the IWTP, a control computer passes into a management computer. This web page is set up to display operating parameters and tank fluid levels.

Plating Facility

This web page provides tank currents and scrubber data.

Fluid Storage Tanks

This web page displays the current level of the tanks, and automatically updates every minute. Click-on icons bring up a history graph of each tank where levels can be displayed for previous day, week, month, or year at user's choice.

Electrical Energy and Power Monitoring

This web page displays the current accumulated total of power usage for all power monitors.

Weather Station

This web page displays the current temperature, relative humidity, wind speed and direction, solar radiation, and accumulated radiation.

12 Server Interface Development

The EMIS project provides a centralized system for gathering, managing, and distributing environmental and plant floor production related data. The main core of this center consists of two "server" hardware and software systems connected to the WVA Intranet where the data are communicated in and out of the system. The servers are located in the Information Management division cluster in Building 20. The two servers are referred to in the following terminology: the **inSQL server** and the **Oracle server**

The inSQL Server

The inSQL Server is a computer with Wonderware industrial SQL (inSQL) COTS server software installed which provides an interface between data generated by the industrial processes and the Oracle server. This data base server is designed to collect rapidly occurring samples of time-stamped data (rather than the more random data inputs typical of commercial applications).

The Oracle Server

This separate Oracle data base server software stores consolidated daily data sets that are passed from the inSQL server. Oracle data records also contain the metadata fields, which are compliant with the DOD data standards.

Bridging the Data Bases

To bridge the two data bases, software was developed and installed on the Oracle server referred to as **bridge** programs. These programs, written in Microsoft Visual Basic,™ perform the following in sequence:

- access the data records from the inSQL data base
- perform any required preprocessing such as averaging, daily highs and lows calculations
- install the records on the Oracle data base.

In addition, Microsoft Internet Information Server (IIS), as discussed above, was installed on a separate machine in the Information Management Division server cluster. This machine is also connected to the WVA Intranet.

Important design goals for EMIS are to streamline all processes, use non-proprietary COTS where possible, and limit the amount of "middleware," or software processes installed between components to interface the two.

The two servers are commercial-grade Pentium XENON class with hot-swappable disk drives and power supplies using RAID for data security. The system is managed by assigned Information Systems Directorate personnel who have attended, or are scheduled to attend specialized training on Oracle and inSQL data base administration. Backups are run on a regular basis.

13 Standardized Data Elements

One of the main issues addressed in designing and developing WVA's EMIS was to use standardized data elements so that data exchange between systems could be accomplished in the future. The EMIS developers selected to use the standardized Department of Defense Data System (DDDS). From DDDS data dictionary and the Department of Defense (DOD) Data Model, data entities and data elements were chosen to match the data needs of EMIS. A data warehouse is the compliant area and the COTS are left in their original form. Management information is transferred by machine and is stored in the data warehouse for long-term use. This section describes the procedures used to comply with the sponsor's request to use DOD standard data elements in the Environmental Management Information System (EMIS) at Watervliet Arsenal.

The steps taken to comply with the sponsor's request included research to learn about the policy and procedures governing the development and administration of the standard data elements. The following sections briefly introduce the agencies responsible for developing and administering the Defense Data Repository Suite (DDRS) and its tools the DOD Data Models (DDM) and the Defense Data Dictionary System (DDDS), respectively.

DOD Data Administration

The Department of Defense (DOD) Data Administration was initiated in accordance with DOD Directive 8320.1 to provide policy, guidance, and tools that would assist in the development, implementation, and enforcement of standardized data. Directive 8320.1 and supporting procedures and manual DOD 8320. 1-M-1 are applicable to all initiatives to develop, upgrade, or migrate information systems, both automated and nonautomated within DOD. Standardized data are important aspects of interoperable systems. Standardization of data provides coordinated means to provide and exchange information, improve communications, and eliminate redundant data across functional areas. More information on standardization is available through:

http://www-datadmn.itsi.disa.mil/8320_1m1.html

Defense Information Systems Agency (DISA)

The DOD Defense Information Systems Agency (DISA) is responsible for executing the policy and procedures as provided by DOD Directive 8320.1 and making available the DOD Data Standards to the community. DISA is the agency that ensures information systems are planned, acquired, developed, and implemented from a DOD perspective. DISA has developed a DOD-wide Defense Data Repository Suite (DDRS) to provide an array of data services for managers and developers. The DDRS provides the user with services and tools that allow access to the DOD Data Models (DDM) and the Defense Data Dictionary System (DDDS). The DOD DDM tool supports the implementation of standard data elements and defines information requirements, business rules, and logical relationships between DOD data standards. DDM is the basis for structuring and defining information requirements and to ensure the reuse of standard data elements within a project. The automated support tool required to access the DDM is the DDDS.

The DOD Data Model (DDM)

The DDM is the current data structure for the DOD. In the DDM, the data are represented graphically through Entity Relationship Diagramming (ERD) technique using a COTS data modeling tool, ERwin/Platinum. A data model is "a graphical and textual representation of analysis that identifies the data needed by an organization to achieve its mission, functions, goals, objectives, and strategies and to manage and rate the organization. A data model identifies the entities, domains (attributes), and relationships (or associations) with other data, and provides the conceptual view of the data and the relationships among data" (FIPS PUB 184 in DOD 8320.1-M-1, p. ix). As DOD information systems are planned, acquired, developed, and implemented, the DDM is one of the components of the infrastructure that supports these objectives. The DDM is an integrated logical data model of data requirements for DOD's functional areas and related components. Standard data items are represented as entities, attributes, and relationships. An entity is defined as "The representation of a set of real or abstract things (people, objects, places, events, ideas, combination of things, etc.) recognized as the same type because they share the same characteristics and can participate in the same relationships" (FIPS BUB 184 in DOD 8320.1-M-1, p. xi). An attribute is "A property or characteristic that is common to some or all of the instances of an entity. An attribute represents the use of a domain in the context of an entity" (FIPS PUB in DOD 8320.1-M-1, p vii). A relationship is "An association between two entities or between instances of the same entity" (FIPS PUB 184 in DOD 8320.1-M-1, p xv).

The Defense Data Dictionary System (DDDS)

The DDDS is the main tool that supports the DOD Data Administration in its position of developing and managing standard data. DDDS is a storehouse that houses and allows centralized management of the DOD Data Models (DDM) and related information. Data Dictionary is defined in DOD 8320.1-M-1 (p ix) as follows:

> A specialized type of data base containing metadata that are managed by a data dictionary system; a repository of information describing the characteristics of data used to design, monitor, document, protect, and control data in information systems and data bases; an application of a data dictionary system.

Metadata (data about data) is defined in DOD 8320.1-M-1 (page xiv) as follows:

> Information describing the characteristics of data; data or information about data; descriptive information about an organization's data, data activities, systems, and holdings.

DDDS allows users to access metadata including name, definition, data steward, field length, data type, and allowable domain values that may be used by software developers in DOD application development. The DDDS provides users with access to approved standard elements and on-line query and reporting capabilities. DDDS provides the mechanism for defining metadata, cross-referencing and consistency checking and supports the standardization of data element names, definitions, and relationships. DDDS users are able to participate in the review and approval of data standards by functionality, identify DOD organizations and processes using standard elements, and track the status of data elements through the standardization process. The following sections describe the phases of the Data Element Standardization Procedures.

Developmental Data Elements

Developmental data elements are those elements that have been created but may not yet be fully specified, appropriate for use, or released by the originator for standardization review.

Candidate Data Elements

Candidate data elements are those elements that have been submitted by a Functional Data Administrator (FDAd) or Component Data Administrator

(CDAd) for formal review. An Office of the Secretary of Defense Primary Staff Assistant designates FDAds. An FDAd is a data steward for a particular functional area and is responsible for defining data requirements for that specific functional area. CDAds review and approve planning, programming, and budget requirements within their respective component. Also, a CDAd is responsible for program administration, implementation, technical infrastructure, and adherence to policy.

Approved Data Elements

Approved data elements are those elements that have been coordinated through the standardization process and have been accepted as DOD standard data elements.

Disapproved Data Elements

Disapproved data elements are those elements that have been coordinated through the standardization process and that have been disapproved for use.

Modified Data Elements

Modified data elements are those elements that were previously approved and are currently being considered for change. These elements go through the same formal review as Candidate data elements.

Archived Data Elements

Archived data elements are those elements that were formally approved but are no longer needed to support the information needs of DOD (Implementing DOD Standard Data Elements).

DDDS Online Registration

The DOD Data Administration requires that users obtain a user ID from the DDDS Help Desk to access DDDS. Double-click on the web site below (DDDS Online Registration.url) to bring up the DDDS online registration form. Complete the required information and click the SUBMIT button to send the request to the proper office. Non-DOD employees must complete the non-DOD section of the form. When the Help Desk receives your request, your will receive by email, telephone, or mail a USERID that you will use to logon to the DDDS. The first

time that you logon, you will be asked to enter a password. The DDDS Help Desk may be contacted at the following locations:

E-mail: rowlandp@ncr.disa.mil
Phone: (703) 681-2166 DSN: 761-2166
Fax: (703) 681-2790; DSN: 761-2790

Or write:
Defense Information Systems Agency
5600 Columbia Pike
Attn: P. Rowland Suite 432
Falls Church VA 22041
http://www-datadmn.itsi.disa.mil/ddds/dddsreg.html

Installing the DOD Data Dictionary

DDDS Installation Procedures

The following are procedures for installing the DDDS on a Desktop to be used as a client to the DDDS server, which is located at the Pentagon in Arlington, VA. This install process should take you approximately 30 minutes. The install programs run rather quickly.

Minimum Hardware/Software Required

- 486 Desktop or higher
- Windows 95 or NT 3.5 or higher
- 75MB Permanent hard disk space (may be a network drive)
- 30MB Temporary space (may be a network drive)
- 2-3MB Permanent hard disk space (for Oracle SQLNET)
- 16MB Random Access Memory (RAM)

The 30MB Temporary space is used to hold the downloadable install files and the install scripts once the download files are unzipped. Once the install is completed this may all be deleted. The install will place the Oracle runtime files in the Permanent hard disk area under a directory called C:\ORANT (C:\ORAWIN95 for windows 95). The DDDS application runtime files will be placed in a directory called C:\ORANT\EXECUTE.

You can specify a network drive location in place of the default C drive. If you already have any ORACLE products installed, but do not have version 4.5 for FORMS and version 2.0 for REPORTS, then you will want to install the DDDS related ORACLE products. When you install these, be sure to install them in the same directory as your existing ORACLE products. To determine if you have

ORACLE installed, look in the "REGEDIT" file for an ORACLE key in the SOFTWARE directory of the HKEY-LOCAL-MACHINE. If you have Windows® NT or WIN95, you can use the START RUN option with REGEDIT as the program.

Major Installation Steps

Step 1: Download the zipped install files (download to \TEMP is recommended)

- INSTORA.exe
- SETUPDDD.exe

Step 2: Install the Oracle and DDDS application

Step 3: Logon to the DDDS by clicking on the DDDS icon and entering userid and password enter DDDS as the data base.

Detailed Installation Steps

Once you have downloaded the executable (*.exe) files to your Desktop use the following instructions to perform the actual installation.

Step 1: Install Oracle Runtime (instORA.EXE)

- Using File Manager or Explorer, double-click the INSTORA.EXE file. The install utility will startup.
- A message will be displayed identifying the install.
- Click OK.
- A message will be displayed indicating the type of Desktop you have.
- Click OK.
- A message will be displayed indicating the home directory that will be used (C:\ORANT or C:\ORAWIN95).
- Click OK to install Oracle Runtime to C:\ORANT or C:\ORAWIN95, or change the directory then click OK.
- An "Installation complete" message will appear.
- Click OK.

Step 2: Install DDDS Runtime (setupDDD.EXE)

If you installed the ORACLE runtime products on a network drive, you will need to run this install of the DDDS application files to the same drive.

- You will also need to run this install on each desktop that is to use the DDDS, but when you run on each desktop, you will answer NO to the prompt to "Install or Connect."
- The "connect" option will only post the registry entries you need on your desktop to run against the network drive.
- Using THE Windows® File Manager or Explorer double-click the SETUPDDD.EXE file.
- A Welcome message will be displayed indicating that you are starting the install. Click OK.
- A Configuration message will be displayed indicating the type of computer you have.
- Click OK.
- Default Destination Directory.
- Change to the drive you installed the DDDS to.
- Click OK.
- Once completed the install program will display confirmation messages.
- Click OK to complete and end the install.

The information for installing the DDDS is taken from the following web site. For more information regarding the DDDS installation procedures, contact:

email: DODDAd@ncr.disa.mil
Phone (703) 735-8010; DSN 653.
http://www-datadmn.itsi.disa.mil/ddds/install.html

Using the DDDS

When you have completed the installing and registration procedures and obtained your Username and Password, you are able to access the DDDS. Open the DDDS and type in your Username and Password as prompted and type DDDS where you are asked for "Data Base." Click on the Connect button to open the DDDS.

Searching for Data Elements

When the opening screen appears, go the top of the screen and press the "Elements" button. A dropdown menu appears. Highlight Standard Data Elements and you will see a number of choices are available for this selection. Choose "Ad-Hoc" query.

An input screen appears and you can type in a name (for example, CHEMICAL) followed by the percent (percent) sign (CHEMICAL%). If you use more than one

word for the name, join the words with the underscore (_) symbol (for example, CHEMICAL_FAMILY), followed by the percent (%) sign (CHEMICAL_FAMILY%). When you have typed in the name of the data element, select the Record button at the top of the page, or press F8. From the dropdown menu, select Execute Query [F8] and the system will search for the selected data element. The search will bring up a list of all data elements that include the words that you typed. If you typed CHEMICAL_FAMILY percent and selected Execute Query, the following data elements are selected from the DDDS: CHEMICAL_FAMILY CATEGORY CODE AND CHEMICAL_FAMILY EXTREMELY HAZARDOUS SUBSTANCE NAME (Table 1).

Table 1. Result of the query.

ID	Version	Name	Status
48619	1	CHEMICAL_FAMILY CATEGORY CODE	A
48621	1	CHEMICAL_FAMILY EXTREMELY HAZARDOUS SUBSTANCE NAME	A

Metadata Reports

To obtain a metadata report of the data element you select from the list (for example, CHEMICAL_FAMILY EXTREMELY HAZARDOUS SUBSTANCE NAME), highlight the data element and go to the buttons at the top of the screen and select "Elements." From the dropdown menu select Reports. When you highlight "Reports," you will be able to select how you want to run the report (for example, By Counter). The Counter is the number in the ID column of Table 1. If you select Counter, a screen will appear and you will type in the Counter ID and press OK.

Another screen gives you a number of options for your report. For metadata detail with domains, select **Print SDE Metadata Detail** and **SDE Metadata with Domain Values and Without NDEs** (SDE = standard data elements and NDE = non-standard data elements).

When you have selected your report type, another screen will appear giving you a number of choices to run the report. To send the report to a file, select File from the pull-down menu. Type the name of the file and the path in the Destination Name Field. The Report Mode must be Character. Press Run Report and your metadata report will be sent to the specified file. To print a report, select Print and Bitmap in the Report Mode field.

Data Administration Updates

The following web site contains the latest innovations to the DDDS:

http://www-datadmn.itsi.disa.mil/

14 EMIS Data Warehouse

Background

Before the installation of EMIS, Watervliet Arsenal already had a management data warehouse for personnel information required by higher level management. Researchers expanded the original warehouse concept by adding another warehouse for production and environmental information. The new warehouse actually consists of sub warehouses or data marts for production and environmental information. The data marts hold information that must be stored for the life of a manufactured article. This information is not required by the higher level management and is not added to the management data warehouse. Data warehouses are classified into two broad categories: enterprise data warehouses and data marts.

Enterprise Data Warehouse

An enterprise data warehouse includes corporate-wide data that has been captured and integrated from many operational systems internal and external to the organization. An enterprise data warehouse is cross-functional and contains detailed as well as summarized data. One rule was that only machine-generated information (by algorithm) went into the enterprise warehouse. WVA will eventually have an enterprise wide data warehouse when all of the data marts are populated and integrated.

Data Marts

A data mart generally contains a subset of corporate-wide data that is of value to a specific user or functional-group of users. Data marts may be further classified depending on their source of data. Independent data marts receive data captured from one or more operational systems or external information sources. Some data stored in an independent data mart may be generated locally from within a department. Dependent data marts receive data directly from the enterprise data warehouse.

Differences Between an Enterprise Data Warehouse and a Data Mart

Enterprise data warehouses are cross-functional and contain detailed corporate-wide data. Data marts support line-of-business and contain subsets of corporate-wide data that are often summarized. A data mart is defined by the functional scope of its users.

Accessing and Managing the Data Warehouse

The skill level of personnel who will access and manage the data warehouse will vary. However since highly skilled personnel may not be available to administer and manage the data mart environment, the use of COTS software and services will be critical to the success of a data mart implementation.

Oracle's Datamart Suites

Since CERL developers used Oracle data base software for the server at WVA, Oracle Datamart Suites software was chosen as the tool for the EMIS data warehousing. In addition, Watervliet Arsenal had decided to use Oracle for other applications that will share the same server. Many of the old mainframe applications at Watervliet Arsenal will migrate to the Oracle server, making it easier to pull information for the datamart as well as transfer information into it. Figure 11 shows a schematic diagram of EMIS data warehousing.

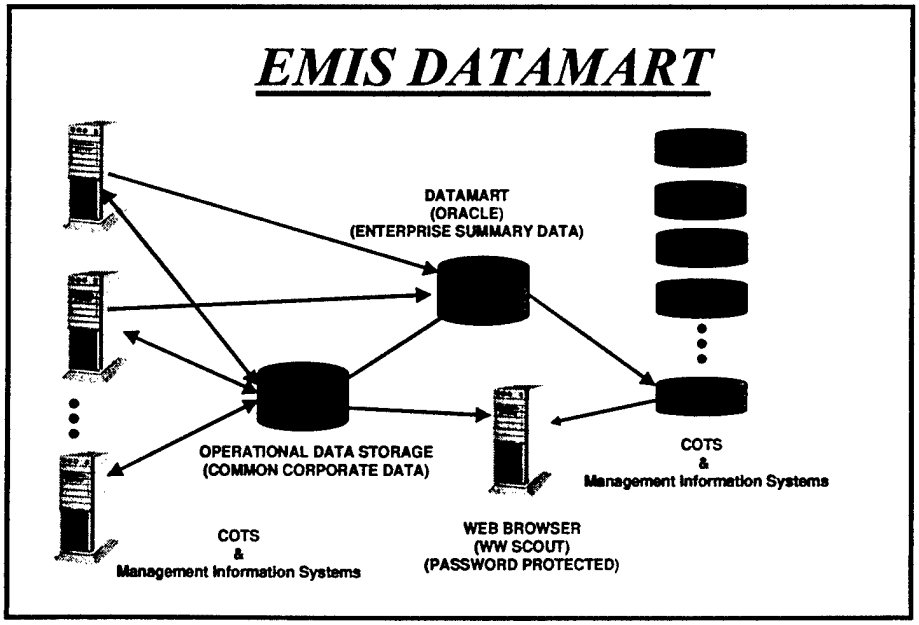

Figure 11. EMIS datamart.

15 ERwin/Platinum (COTS) Data Modeling Tool

Originally, Logic Works, Inc. developed ERwin. It was later acquired by another company and renamed "Platinum," and in a later transaction, Computer Associates (CA) acquired the software. The first version of ERwin was released in 1990. Version 3.5.2, released in August 1998, was used in the development of EMIS. ERwin is FY2000 compliant.

ERwin is a data base design tool for client/server system development. It combines a Windows® graphical interface, entity-relationship (ER) diagramming tools, custom editors to define logical and physical data base objects, and support for SQL and desktop data bases. The software helps you create or re-engineer relational data bases to work in a client/server environment. Table 2 lists the ERwin properties.

Table 2. ERwin compatibility and requirements.

ERwin Application Software Compatibility	ERwin Data Base Compatibility	ERwin Operating System Compatibility	ERwin Technical Requirements
NetDynamics	CA-Clipper CA-OpenIngres DB2 for MVS DB2 for OS/390 DB2 UDB for AS/400, DB2 UDB, DBASE, FoxPro, HiRDB, Informix	Windows NT	Minimum 10 MB hard disk space
PowerBuilder	InterBase, Microsoft Access	Windows 95	16 MB RAM
Progress	Microsoft SQL Server, Oracle, Paradox, Progress, Rdb, Red Brick Warehouse, SAS, SQL Anywhere	Windows 98	32 MB RAM recommended for large models
Visual Basic	SQLBase, Sybase, Teradata		

http://platinum.com/products/factsht/ERwin_fs.htm)

Using ERwin to Design and Build the EMIS Model

Before building a model, you must understand the process that you are modeling and the business rules that govern it. The first step in building EMIS was to facilitate a workshop at WVA that included personnel from upper management,

first-line management, information management, and workers responsible for recording data from sensors in the various industrial cells. It is important to include all relevant personnel in the initial planning session so that everybody has input to important facets of the process and relevant data elements are not excluded. CERL researchers used the ERwin software as the basis for developing the data map that now resides on the Oracle server at Watervliet Arsenal.

Selecting ERwin Data Maps

The first task was to select from the available maps in ERwin those that contained tables and data elements that were to be included in EMIS. Tables to be included in the WVA EMIS were copied into a new ERwin file. The new tables were linked together, as appropriate.

Change Logical Entity Names to Access Names

Logical Entity Names were changed to DDDS authorized Access Names to avoid truncation and subsequent duplication of names when the ERwin maps were forward engineered into an Oracle data base.

Add Dynamic Data Elements

The next task was to add dynamic information not included in the ERwin models. In some cases, a single data element may have been missing from a table, and in other instances new tables were added. The addition of dynamic data elements such as "amperage," "gallons per hour," and "pressure change" was important so that information from sensors could be aggregated for the long term. Since this was the original intent of EMIS at WVA, the dynamic elements were added.

Add Domains to Data Elements

In the DDDS, some data elements are associated with Domains. These Domains appear in a table at the end of a Metadata report. Each Domain associated with a particular data element has a Domain Value ID and Domain Definition Text. This was Forward Engineered into the Oracle data base with the WVA map.

Metadata Reports

A further addition was to insert links from each DDDS data element in the WVA MAP to its corresponding Metadata report. To do this, select Physical view and go to Edit and Go To. From the table that appears, select a Table Name. Right

mouse click to open the Table and select Column Editor. Highlight a Column Name and select UDP at the right of the list of Column Names. Select METADATA and the Metadata corresponding to the selected Column Name will appear.

Forward Engineering a Data Model

To access the Forward Engineering option, select **Tasks** at the top of the screen and go to **Forward Engineer/Schema Generation ...** from the pull-down menu. Mouse click to follow instructions to Forward Engineer your ERwin map.

Forward Engineering a data model allows you to create a new data base schema from an ERwin model. You can accomplish this by either saving it as a script file or by applying the changes directly against your data base catalog. The Forward Engineering process is used for first-time creation of tables, triggers, stored procedures, and other data base objects. When the ERwin WVAMAP was completed, it was Forward Engineered into an Oracle Data Base at CERL and then sent electronically to the Oracle data base at WVA.

Reverse Engineering a Data Base

To access the Reverse Engineering option, select **Tasks** at the top of the screen and from the pull-down menu go to **Reverse Engineer ...** . Mouse click to follow instructions to Reverse Engineer your existing data base into ERwin.

Reverse Engineering allows you to create a new ERwin model from an existing data base or SQL DDL script. Choose this item from Tasks at the top of the screen.

16 Other COTS Associated with EMIS

Hazardous Materials Information Network (HAZMIN)

HAZMIN® was developed by Logical Technology, Inc. This software combines comprehensive environmental reporting with hazardous materials and Material Safety Data Sheet (MSDS) management. HAZMIN software includes the following modules:

- MSDS Management Module
- Environmental Reporting Module
- Regulated Substance Data Base Module
- Material Process Control Module.

MSDS Management Module

This module is the core of HAZMIN. Using this module allows you to store, display, and print MSDSs; document usage locations; and perform many other functions. Reporting options enable users to query all of the MSDS fields and lines of text in an MSDS to create custom reports. If this module is combined with the Regulated Substance Data Base Module, the authorized user can determine the MSDSs that contain regulated hazardous materials.

Environmental Reporting Module

This module provides a simple interface for sophisticated, integrated, environmental reporting. When this module is combined with the Regulated Substance Data Base Module and MSDS Management Module, information from the MSDS can automatically be used to determine those materials that should be reported and to consolidate chemical reporting.

Regulated Substance Data Base Module

This module allows users to stay current with chemical regulations and advisory information from over 150 lists from various environmental agencies. Reports from all agencies regulating a chemical can be searched.

Material Process Control Module

This is a comprehensive hazardous materials management program. It is designed to document standard operating procedures for all hazardous materials within a facility or organization.

HAZMIN and WVA EMIS

HAZMIN was installed at WVA about 10 years ago to track all of the hazardous materials coming on to the installation and all of the hazardous waste leaving the installation. All of the MSDSs are stored in the system.

In the future, MSDSs will be shared with another COTS (iSteps) that is used to generate the Title V reports. Also, dynamic information from the EMIS data warehouse will be added to the HAZMIN reports.

This information was obtained from the following web site

http://www.comply1.com/hazmin.htm

i-STEPS

i-STEPS is a product of Pacific Environmental Services (PES), Inc. This COTS manages the environmental-specific data for a facility by providing standard and user-specific calculations to estimate the quantities of a release and many standard forms for meeting reporting requirements to regulatory agencies. The i-STEPS design assists users with air emissions inventory and compliance with the Title V requirements of the Clean Air Act (CAA), waste management according to the Resource Conservation and Recovery Act (RCRA) and wastewater tracking under the National Pollution Discharge Elimination System (NPDES) regulations. Other i-STEPS capabilities and i-STEPS reports are listed in the following sections.

i-STEPS Capabilities

- Manages emissions from all types of point, area, mobile, and biogenic sources
- Manages chemical attributes of process and emitted compounds
- Manages MSDS information on substances used/stored
- Calculates air emissions via AP-42 or site specific factors
- User-defined equations can be developed for calculating emissions
- Handles continuous, batch and assembly line processing oriented facilities
- Maintains all media data on a temporal basis for time critical reports

- Automatically provides permit limitation warnings
- Produces an audit trail of data modifications
- Client/Server (Air) and File/Server versions available
- Provides end-user configuration capabilities
- Provides user level security.

i-STEPS Reports

- SARA 313 Form R
- SARA Tier II
- Discharge Monitoring Report
- Hazardous Waste Manifest
- Biennial Report
- Electronic Emissions Inventory Submittal
- Graphical ad-hoc report writer that can reproduce multicolor forms and graphs, and generate virtually any report.

This information was obtained form the PES web site:

http://www.i-steps.com/index0.html

i-STEPS and WVA EMIS

i-STEPS was purchased by Industrial Operations Command (IOC) for WVA to be used as a data base for the Air Monitoring Inventory, before the commencement of the EMIS project. At present the Air Monitoring Inventory resides on another data base at WVA, and the information has not yet been transferred to i-STEPS. Eventually, i-STEPS will use dynamic data from the EMIS data warehouse to populate

Wonderware

Wonderware introduced InTouch™ HMI software in 1989. Since then, Wonderware has rapidly become the world leader in industrial automation solutions, offering the Wonderware FactorySuite™ of products that span the enterprise, from the factory floor to the executive offices—from supervisory control and data acquisition (SCADA) applications to production management and resource tracking, flexible batch management, expert machine diagnostics, and connectivity products to link them to control devices and computing networks.

Wonderware FactorySuite 2000

FactorySuite™ 2000 is the world's first integrated, component-based man-machine interfaces (MMI) System. With FactorySuite 2000, you have access to all the information you need to run your factory including, visualization, optimization and control, plant floor data collection, and data storage and analysis.

FactorySuite 2000 Core Components

- *InTouch*, the world's leading HMI for visualization
- *InControl* for Windows NT-based machine and process control
- *IndustrialSQL* Server, the first real-time relational data base for the plant floor
- *Scout*, a robust Internet/Intranet tool for remote data viewing.

InTouch

InTouch enables engineers, supervisors, managers, and operators to view and interact with the workings of an entire operation through graphical representations of their production processes. Version 7.0 for Windows NT 4.0 and Windows 95 includes a host of new and updated features including remote tag referencing, ActiveX support, distributed alarm handling, distributed historical data with IndustrialSQL Server, updated user interface, QuickFunctions and SuperTags. Additionally, the network application development environment allows systems to be developed for use in large PC-based networks. InTouch's legendary ease-of-use and power dramatically reduce the cost and time associated with deploying and maintaining operator interface/HMI systems.

Included with InTouch is FactoryFocus, a powerful, view-only node that enables supervisors and managers to view real-time plant floor data from a desktop PC anywhere on the network. InTouch 7.0 also contains the Wonderware Productivity Pack, which includes WizGen, a handy software tool that helps users to develop custom wizards. The Productivity Pack has more than 2,000 wizards that make application development easier than ever before.

IndustrialSQL server

IndustrialSQL Server is the world's first high-performance real-time relational data base for factory data. It combines the power and flexibility of a relational data base with the speed and compression of a real-time system to integrate the office with the factory floor. Unlike other Process Information Management Systems, IndustrialSQL Server embeds Microsoft SQL Server,™ providing universal

data access, a powerful relational engine, and tight integration with Microsoft BackOffice.

IndustrialSQL Server acquires and stores plant data at full resolution, and integrates real-time and historic plant data with configuration, event, summary, and production data. Access to complete plant information is available through hundreds of client applications, ensuring a level of openness and flexibility unmatched in the industrial software arena. Factory data can now be visualized, analyzed, and reported across the enterprise—truly linking the office with the factory floor for the first time.

Base "Application" Components

- *InTrack for resource management.*
  Wonderware InTrack provides a Windows NT-based, scalable, cost effective means to monitor, manage, track, and improve production operations. InTrack allows manufacturers to model and track critical resources in a factory, including work orders, materials, product specifications, work instructions, equipment, people, and process/analytical data. InTrack enables users to implement client/server applications that help them to control and improve their manufacturing operations in a fraction of the cost and time of alternative approaches.
- *InBatch for flexible batch management.*
  Wonderware InBatch is flexible batch management software designed to automate and provide a complete production history for batch processes. Consistent with the Instrument Society of America (ISA) S88.01 standard, InBatch allows you to quickly and easily create recipes and simulate their execution against a model of the process—all before writing one line of control code. InBatch also provides complete production history and materials genealogy. InBatch's powerful batch engine, combined with its integration with FactorySuite 2000, allows you to reduce the cost and time to implement your batch-related processes by up to 40 to 60 percent over competitive solutions.

Plus all Wonderware I/O Servers to connect FactorySuite 2000 to the data on the plant floor. Figure 12 shows a schematic diagram of FactorySuite 2000.

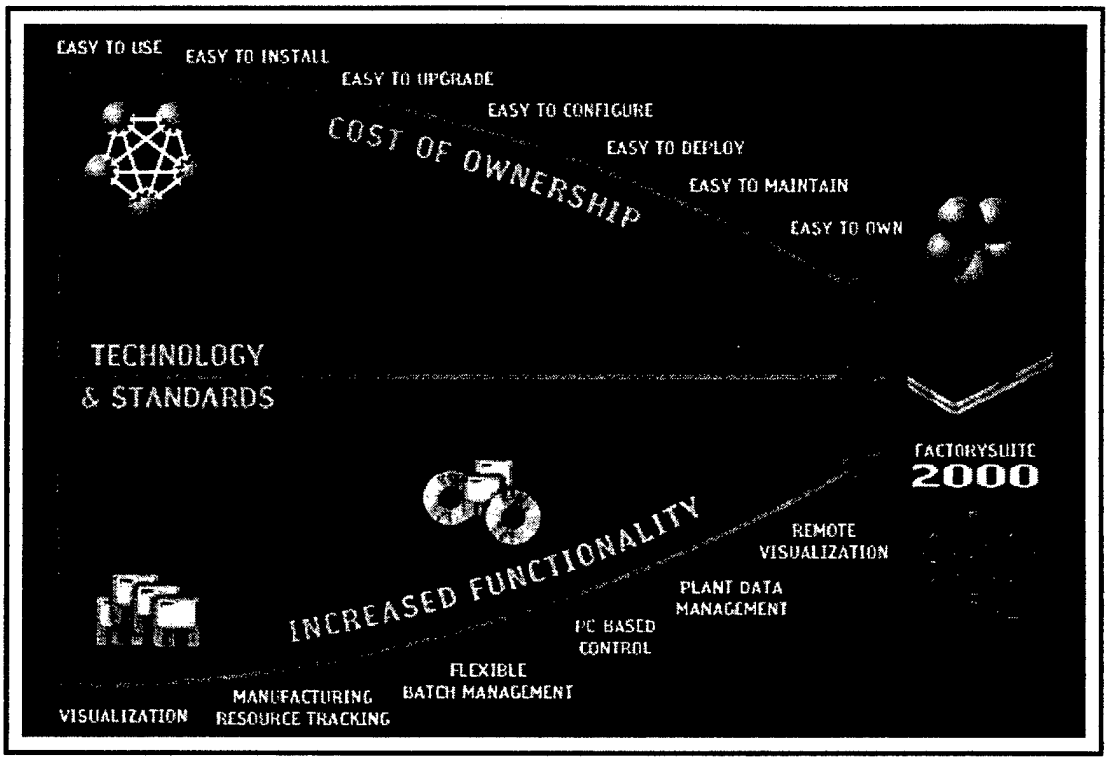

Figure 12. FactorySuite 2000.

This information was obtained from the Wonderware web site:

http://www.wonderware.com/Products/frm_factorysuite.htm

Wonderware and WVA EMIS

Wonderware tracks what is happening in the process, for example, how much heat is used, number of amps, how many pieces are produced, who produced these pieces and when, and who made mistakes in the process.

17 Training

For WVA to take over the management of EMIS, training was necessary for the following personnel.

SQL Training

Walt Dugan, Tom Pond, Bruce Pienkoski

Oracle Administrator

Dennis O'Dell and one other.

ERwin/Platinum

Dennis O'Dell.

Maximo

One individual.

18 Future EMIS Projects

Boiler Automation and Steam Meter Connection to EMIS

This includes building steam meter connection to EMIS. The project should qualify for Corps D048 funding for Continuous Emissions Monitoring System (CEMS) for opacity and NOx. (This project is already in the approval stage.) Note that Windows NT computer with Wonderware Factory Suite 2000 is already installed in the boiler room and is ready to accept EMIS data.

ECMS (Energy Monitoring Process Energy and Pollution Reduction [PEPR] Spin-Off)

- *Gas Meters*. Connect three natural gas mains to EMIS.
- *Water Meters*. Connect four mains to EMIS.
- *Steam Meters*. Connect mains to EMIS.
- *Shop Compressed Air Monitors*. Measure differential pressure to detect flow (leaks) between air supply and buildings. Links to EMIS.
- *Shop Air Compressors*. Excessive cycling (possible air/energy loss). Links to EMIS.

IWTP SO_2 Tank Meters (PEPR Spin-Off)

Replace tank weight cell system.

IWTP Sulfur Abatement/Scrubber

Remove/recover sulfur from air waste stream. (This is a possible candidate for Corps D048 funding contribution.)

Magnetic Drive Pumps (Value Engineering Spin-Off)

The installation of magnetic gas pumps may qualify for Corps D048 funding contribution as water use reduction. This will include replacing existing leaky pumps with magnetic drives in 120 Chrome Plate area. This equipment would eliminate cooling water waste and leaky seals. This technology has been used in IWTP for 8 years with only one failure.

Catastrophic SO_2 Abatement

40CFR drives project requirements for SO_2 abatement.

Facilities Controls and Monitoring System

Provide control to Heating, Ventilation, and Air Conditioning systems in the Arsenal. This will be a future main in EMIS (cf. Figure 1).

19 Summary

As the Department of Defense (DOD) continues to downsize its infrastructure and manpower, efficient and careful allocation of fewer resources is paramount. The role of automated systems will assume an increasingly high priority as fewer human resources become available to complete jobs previously done by a larger workforce. With these facts in mind, researchers developed the Watervliet (WVA) Environmental Management Information System (EMIS). This system was designed to provide a widespread environmental risk control network, by automating the gathering of real-time data and manually entering data and transferring the data to a data warehouse (Datamart).

Although production rates have decreased at WVA over the years, it is still a functional production installation. This was of twofold benefit to researchers. The functional installation could be used as a field laboratory to test new equipment and techniques, without interrupting the workers or disrupting their output.

The use of DDDS standard data elements and Erwin/Platinum software ensures that EMIS could be readily adapted to other situations in other Army installations.

One of the main goals in developing the Environmental Management System at Watervliet Arsenal, was to use (whenever possible) information management systems, sensors, and hardware already in place. Several other projects were being completed at Watervliet Arsenal in the same time frame, so sensors that were compatible to all projects were used.

Researchers have found that most sensor arrays can now be connected to PLCs and COTS. This fact alone could have saved millions of dollars for the Army if it had standardized its data according to the DOD Data Dictionary System (DDDS), instead of writing proprietary environmental software.

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Office of the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence), *Data Standardization Procedures*, DOD 8320.1-M-1 (April 1998).

Northrup, Jearldine, Joyce C. Baird, and Don Schiller, *Remote Monitoring of Fluid Storage Tanks at Watervliet Arsenal, New York* Technical Report (TR) 98/108/ADA352918 (U.S. Army Construction Engineering Research Laboratories [CERL], August 1998).

Appendix: DOD Data Architecture 2000

The DOD Data Architecture 2000 was released 29 December 1999. The DOD Data Architecture Views and document files are contained in *.zip (compressed) format files, from which users can select data elements and corresponding meta-data reports. These files are available for download from the following website:

http://www-datadmn.itsi.disa.mil/datadmn/dda2000/ddmhmpg.htm

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14. ABSTRACT

Watervliet Arsenal (WVA) and the U.S. Army Construction Engineering Research Laboratory (CERL) developed the Environmental Management Information System (EMIS) to supply the missing connections to the stand-alone systems already in place and in use. EMIS is an automated tracking system designed to provide "cradle-to-grave" tracking of hazardous materials and their chemical constituents. EMIS gathers environmental information throughout WVA and provides this information to compliance officers, to the plant floor, and to operations and alarm personnel when compliance is exceeded. The system can generate reports to meet all regulatory requirements and to assist in the centralized management of all environmental issues at WVA.

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